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(54) Abstract Title

Programmable logic control system

(57) The system is capable of executing a plurality of functions to realize high speed data communication without performance degradation between control input/output unit 6 and modules 4, 5. At least one operating section module 5 stores and runs control programs and a plurality of input/output section modules 4 are connected to the devices to be controlled (Fig. 2). Modules 4, 5 connect to a backboard 16 via connectors 17, 18 or directly to each other (Fig. 5). Connectors 17 communicate with each other and unit 6 by means of bus 1, communication element 2 and connectors 19, 21.

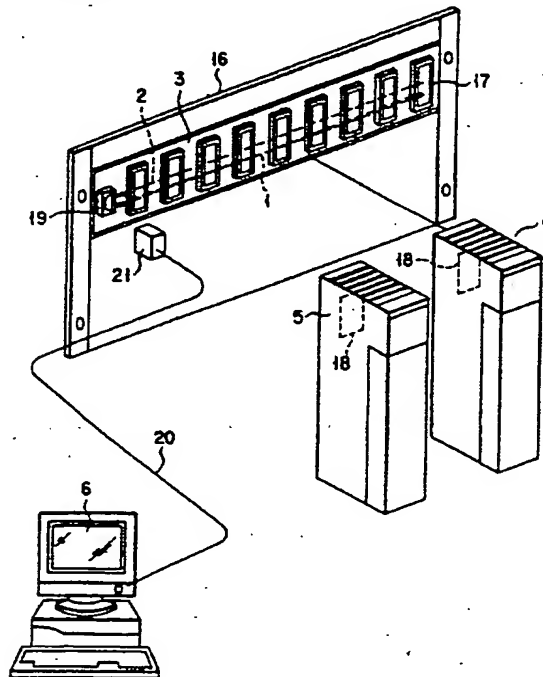


FIG. 1

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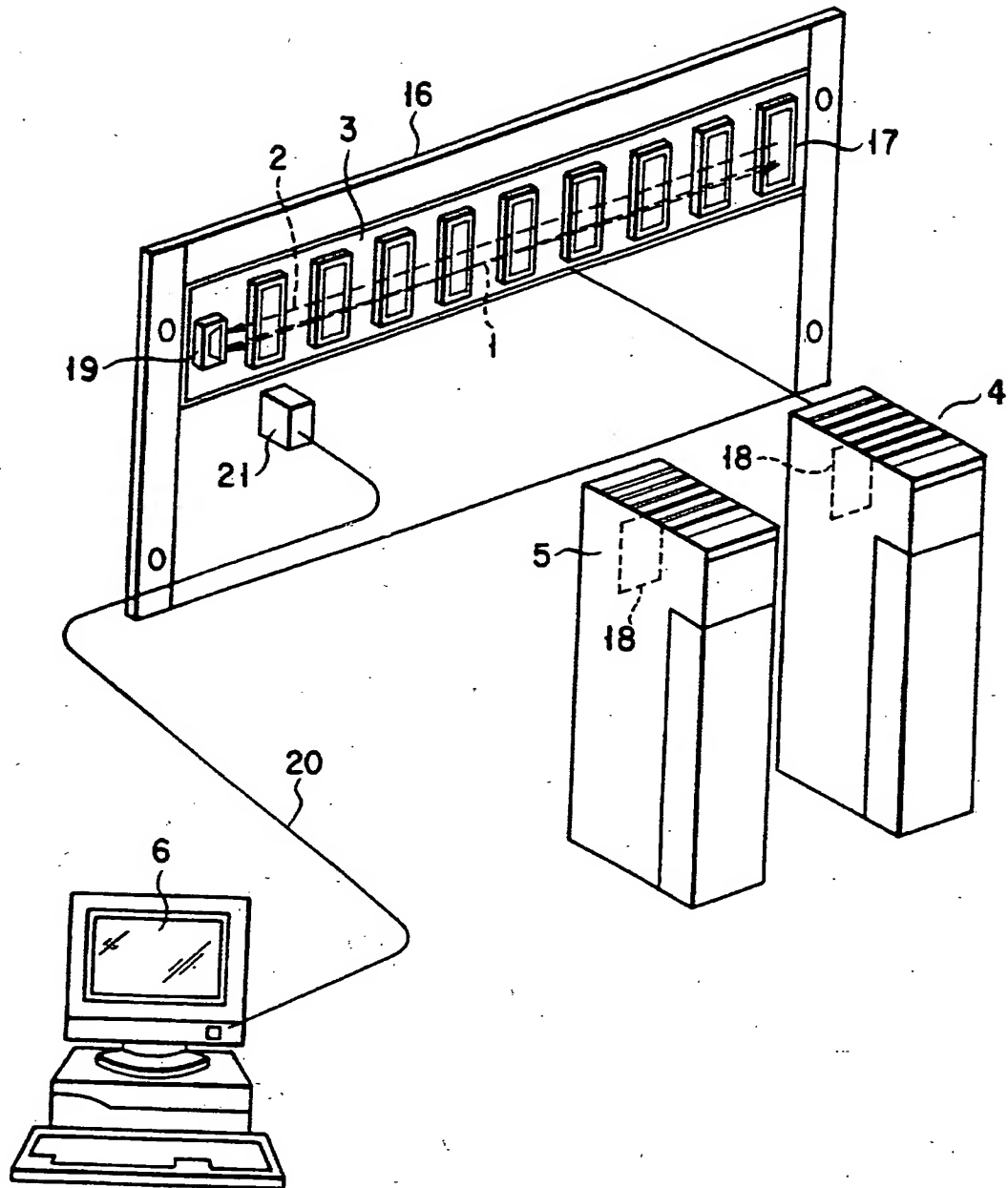


FIG. 1

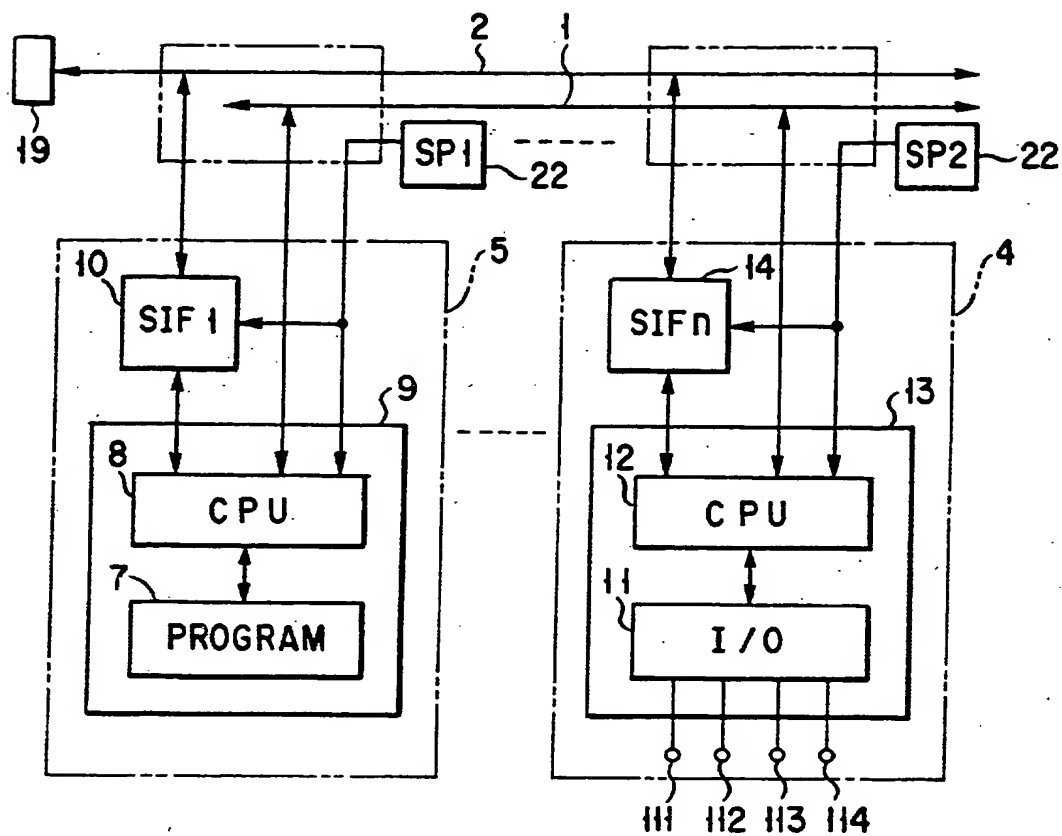


FIG. 2

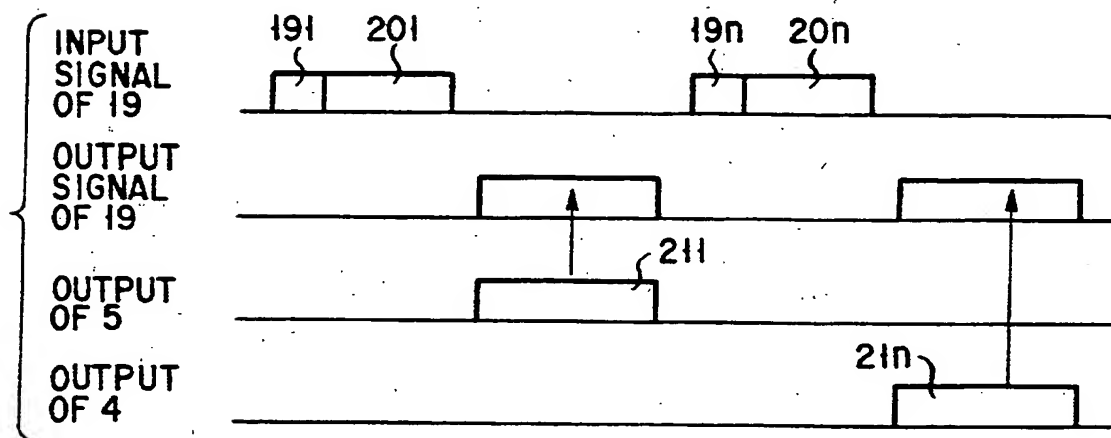


FIG. 3

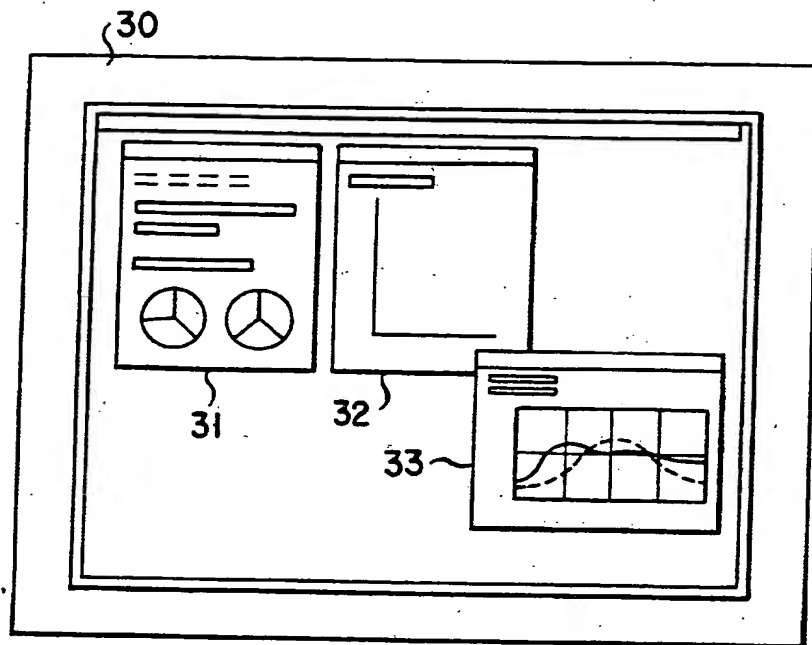


FIG. 4

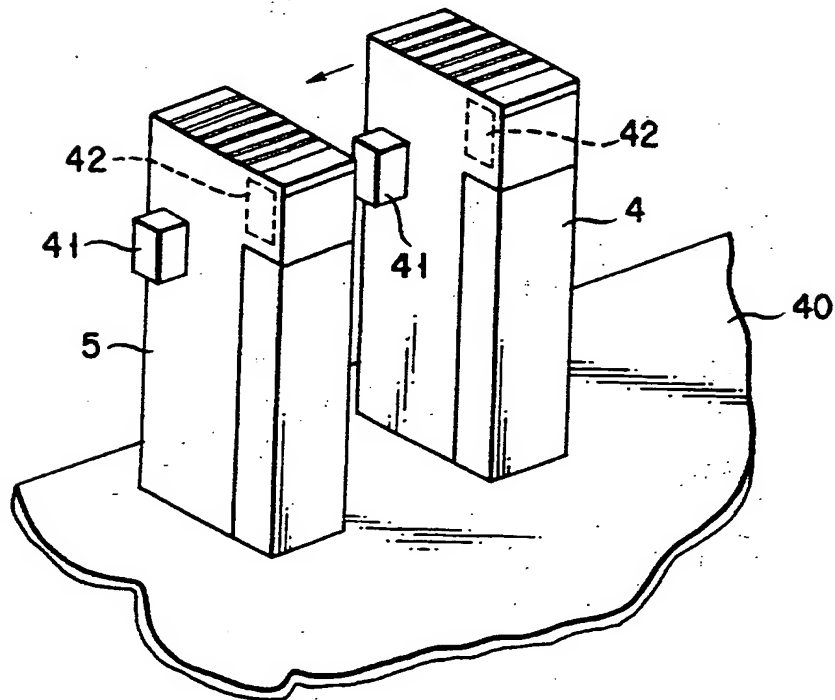


FIG. 5

TITLE OF THE INVENTION

PROGRAMMABLE LOGIC CONTROL SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a programmable logic control system (hereinafter referred to as a "PC"), and more particularly to a programmable logic control system in which a control command from a common control input/output unit is supplied to controllers incorporated in the programmable logic control system and having operation units and input/output sections, thereby controlling a plurality of objects connected to the input/output sections.

In general, programmable logic control systems PC each comprise central processing units (hereinafter referred to as "CPUs") and a plurality of input/output sections (hereinafter referred to as "I/O sections"). Programmable I/O sections, for example, which contain microprocessors and are highly functional, are more and more increasing.

Such highly functional I/O units are used to interface each peripheral unit, i.e. each control input/output unit, with at least one object via the CPU of the control input/output unit. In the case of I/O units which require special programming, they are generally provided with terminals to be connected to a special control input/output unit.

The conventional PC is generally connected to

at least one object via the CPU of each control
input/output unit. Therefore, the larger the number of
highly functional I/O units and hence the greater the
amount of information and the contents of processing,
5 the greater the load on the CPU.

Moreover, where a plurality of I/O units which
can be directly connected to an exclusive control
input/output unit are used, it is also necessary to,
for example, change the connection between the control
10 input/output unit and the I/O units.

The CPUs of the conventional PC concentrically
manage the interfacing function to interface control
input/output units with objects. Since the amount of
information to be controlled by the CPUs is more and
15 more increasing these days, the load on the CPUs is
accordingly increasing.

On the other hand, in the case of personal
computers used as the control input/output units, a
multi-task operation in which a plurality of processing
20 or images are simultaneously treated has come to be
widely performed in accordance with enhancement of
hardware performance.

In light of the above, development of a programma-
ble logic control system is now being desired, which
25 enables control input/output units to execute a plural-
ity of functions, without degrading the performance of
the programmable logic control system, in order to

perform high-speed data communication.

BRIEF SUMMARY OF THE INVENTION

It is the object of the invention to provide a programmable logic control system capable of executing
5 a plurality of functions to realize high speed data communication between itself and a control input/output unit without degrading its performance, thereby significantly enhancing the performance and simplifying maintenance.

10 To attain the object, the invention according to claim 1 relates to a programmable logic control system for supplying control instructions output from a common control input/output unit, to controllers incorporated in the programmable logic control system and having
15 operating sections and input/output sections, thereby controlling a plurality of objects connected to the input/output sections.

The programmable logic control system comprises:
a plurality of separate input/output section modules
20 obtained by grouping the operating sections and input/output sections in the form of separate modules, and connected parallel to a bus; at least one separate operating-section module corresponding to the operating sections of the controllers, and connected parallel to
25 the bus; and a communication signal transmitting element which electrically connects the control input/output unit to each of the separate input/output

section modules.

This structure enables communication between the control input/output unit and each separate module during use of the bus, with the result that high-speed data communication can be performed between each separate module and the control input/output unit without degrading the performance of the PC.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments give below, serve to explain the principles of the invention.

FIG. 1 is a perspective view, illustrating the manner of connection between a PC main body according

to a first embodiment and a control input/output unit;

FIG. 2 is a block diagram, showing the PC main body of the first embodiment;

FIG. 3 is a view, useful in explaining a communication procedure employed in the FIG. 2 programmable logic control system;

FIG. 4 is a view, showing the screen of the control input/output unit of FIG. 1; and

FIG. 5 is a perspective view, useful in explaining an essential part of a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The embodiment of the invention will be described with reference to the accompanying drawings.

<First Embodiment>

FIG. 1 is a perspective view, illustrating the manner of connection between a PC according to a first embodiment, i.e. a PC main body which will be described, and a control input/output unit 1 such as a personal computer. FIG. 2 is a block diagram, showing the PC main body of FIG. 1.

The PC according to the invention is constructed such that it supplies control instructions output from a common control input/output unit 6, to controllers incorporated in the PC and having CPUs and input/output (I/O) sections. Specifically, the PC supplies instructions from the common control input/output unit 6, to ports 111, 112, 113 and 114 of each input/output section 11 incorporated in the PC and shown in FIG. 2, thereby controlling a plurality of objects connected to

the ports, such as a temperature control unit, a valve and a flow control unit.

The PC comprises a back board 3 formed of an attachment plate such as a printed board fixed to a base unit 16 and provided with a bus 1 and a communication signal pattern 2; a plurality of separate input/output section modules 4 (only one of the modules is shown in the figure) obtained by grouping the input/output sections of the controllers in the form of separate modules, mounted on the back board 3, and connected electrically and in parallel to the bus 1 and the communication signal pattern 2; at least one separate operating-section module 5 connected electrically and in parallel to the bus 1 and the communication signal pattern 2; and a common peripheral unit, i.e. the common control input/output unit 6, connected electrically and in parallel to the bus 1 and the communication signal pattern 2. Communication can be performed, during use of the bus, between each of the separate modules 4 and 5 and the control input/output unit 6.

The separate operating-section module 5 includes a memory 7 which stores control programs for controlling the objects, an internal inherent circuit 9 which consists of an operation unit (CPU) 8 for carrying out the control programs, and a serial communication circuit 10 interposed between the operation unit 8 and

the communication signal pattern 2 for converting parallel signals output from the operation unit 8 to serial signals and imparting the serial signals to the control input/output unit 6.

5 Each separate input/output section module 4 includes an internal inherent circuit 13 which consists of at least one input/output section (input/output port) 11 (four input/output sections 11 in the FIG. 2 case) and an operation unit 12 for transmitting the
10 input/output signals of the input/output section(s) to the communication signal pattern 2, and also includes a serial communication circuit 14 interposed between the module 4 side operation unit 12 and the communication
15 signal pattern 2 for converting parallel signals output from the module-side operation unit 12 to serial signals and imparting the serial signals to the control input/output unit 6.

 The electric connection between each separate module 4, 5 and the bus 1 and the communication signal
20 pattern 2 of the back board 3 is realized by inserting module-side connectors 18 incorporated in the separate modules 4 and 5, into the back board 3 so that they will be connected to substrate-side connectors 17.
 When the connectors 17 and 18 are disconnected, the
25 modules and the bus 1 and pattern 2 of the back board 3 are disconnected.

 The electric connection between the common control

input/output unit 6 and the bus 1 and the communication
signal pattern 2 of the back board 3 is realized by
inserting, into the back board 3, an input/output side
connector 21 connected to an electric cable 20 which is
5 electrically connected to the control input/output
unit 6, so that the connector 21 will be connected to a
substrate-side control input/output unit connector 19
incorporated in the back board 3. When the connectors
19 and 21 are disconnected, the control input/output
10 unit 6 and the bus 1 and pattern 2 of the back board 3
are disconnected.

Further, the connectors 17 of the back board 3
include address recognition means 22 for providing the
input/output separate modules 4 with, for example, slot
15 detection signals SP1 - SPn indicative of addresses
corresponding to the mount positions of the modules 4,
when the substrate-side module connecting connectors 17
are connected to the module-side connectors 18.

The address recognition means 22 may be modified
20 such that they are located on the back board 3 in the
vicinity of the connectors 17 and 18 which are provided
corresponding to the separate input/output section
modules 4, so that they will recognize the address of
each separate module 4 from that signal just for
25 detecting the mount position of the module, which
indicates, for example, the manner of connection of
a certain fixed pattern formed on the back board 3 or

a switch mechanism provided thereon.

Since in the embodiment described above, the control input/output unit 6 is electrically connected to each separate input/output section module 4 and each
5 separate operating-section module 5 via the communication signal pattern 2 formed on the back board 3, high-speed data communication can be performed between each separate module 4, 5 and the control input/output unit 6 without degrading the performance of the PC.

10 On the other hand, in the conventional PC, a connector to be connected to the control input/output unit 6 is provided for each separate module 4, and no communication pattern 2 as shown in FIGS. 1 and 2 for electrically connecting each connector and a
15 corresponding separate module 4. Accordingly, the performance of the PC is degraded, high-speed data communication cannot be performed, and a plurality of functions cannot be executed.

FIG. 3 shows an example of a communication
20 procedure assumed when request of data is issued from the control input/output unit 6 to the input/output separate modules 4. In the figure, the control input/output unit 6 side provides the control input/output unit connectors 19 with input signals
25 which indicate addresses 191, ..., 19n and data request commands 202, ..., 20n.

The operation units 8 and 12 of the separate

modules 4 and 5 compare the addresses 191, ..., 19n with the addresses of the separate modules 4 and 5, and return response data 211, ..., 21n of the modules 4 and 5. Accordingly, a single communication signal pattern 2 as a communication line can deal with a plurality of separate modules 4, and the CPU is not required to relate to all processing unlike the conventional case.

On the other hand, when the control input/output unit 6 is connected to the PC main body of the invention, it can take out any information from the separate modules 4 and 5 without degrading the performance of the PC, thereby providing high-speed response. Therefore, if a computer which can perform a multi-task operation is used as the control input/output unit, a plurality of information items concerning a CPU or a highly functional input/output section can be monitored at a time easily.

FIG. 4 shows examples of window images simultaneously displayed when a computer capable of performing a multi-task operation is used as the control input/output unit. In FIG. 4, reference numeral 30 denotes a control input/output unit display, on which monitor information items 31, 32 and 33 based on data from the PC main body are displayed. Monitor information 31 concerns circle graphs corresponding to equipment's names, monitor information 32 a graph corresponding to

the equipment's names, and monitor information 33 a trend corresponding to them.

Even if quite different information items are displayed in combination in the window, they can be
5 obtained from a single communication line without being influenced by the performance limitation of the PC main body due to its CPU. Accordingly, a single control input/output unit 6 can be used commonly for all the operation units CPU and the input/output (I/O) units of
10 the separate modules.

<Another Embodiment>

Although in the above-described embodiment, the separate modules 4 and 5 are mounted on the back board 3 fixed to the base 16, the base 16 and back
15 board 3 may be omitted and the PC be constructed as follows:

As shown in FIG. 5, the separate modules 4 and 5 are directly fixed on a object 40, a male connector 41 and a female connector 42 are attached to each separate
20 module 4, 5, and the male and female connectors 41 and 42 attached to adjacent surfaces of the separate modules 4 and 5 are connected to each other. As a result, the bus 1 and the communication signal pattern 2 shown in FIG. 1 can be omitted.

25 Moreover, in the FIG. 5 case, a communication signal transmission plate or line and a bus plate or line, for example, may be used in place of the male and

female connectors 41 and 42.

In addition, in FIGS. 1 and 2, a communication signal transmission plate may be used instead of the communication signal pattern 2.

5 Additional advantages and modifications will readily occurs to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various
10 modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

CLAIMS

1. A programmable logic control system for supplying control instructions output from a common control input/output unit, to controllers incorporated in the programmable logic control system and having operating sections and input/output sections, thereby controlling a plurality of objects connected to the input/output sections, comprising:
 - a plurality of separate input/output section modules obtained by grouping the input/output sections of the controllers in the form of separate modules, and connected parallel to a bus;
 - at least one separate operating-section module obtained by grouping the operating sections of the controllers in the form of a separate module, and connected parallel to the bus; and
 - a communication signal transmitting element which electrically connects the control input/output unit to each of the separate input/output section modules;
- wherein the control input/output unit can communicate, during use of the bus, with each of the separate input/output section modules and the at least one separate operating-section module.
2. A programmable logic control system for supplying control instructions output from a common control input/output unit, to controllers incorporated in the programmable logic control system and having

operating sections and input/output sections, thereby controlling a plurality of objects connected to the input/output sections, comprising:

5 a mount board on which a bus and a communication signal pattern are formed;

10 a plurality of separate input/output section modules obtained by grouping the operating sections of the controllers in the form of separate modules, mounted on the mount board, and connected electrically and parallel to the bus and the communication signal pattern; and

15 at least one separate operating-section module mounted on the mount board, and connected electrically and parallel to the bus and the communication signal pattern;

20 wherein the common control input/output unit is electrically connected to the bus and the communication signal pattern, such that the control input/output unit communicates, during use of the bus, with each of the separate input/output section modules and the at least one separate operating-section module.

3. A programmable logic control system according to claim 1 or 2, wherein:

25 the at least one separate operating-section module includes a memory which stores control programs for controlling the objects, an internal inherent circuit which consists of an operating unit for executing

the control programs, and a serial communication circuit interposed between the operating unit and the communication signal transmitting element or the communication signal pattern, the serial communication circuit converting a parallel signal output from the operating unit, into a serial signal and supplying the serial signal to the control input/output unit; and

each of the separate input/output section module includes an internal inherent circuit which consists of at least one input/output section and an operating unit for supplying the communication signal transmitting element or the communication signal pattern with an input/output signal from the at least one input/output section, and a serial communication circuit interposed between the operating unit of each of the separate input/output section module and the communication signal transmitting element or the communication signal pattern, the serial communication circuit converting a parallel signal output from the operating unit of the separate input/output section module, into a serial signal and supplying the serial signal to the control input/output unit.

4. A programmable logic control system according to any one of claims 1 - 3, wherein electrical connection between each of the separate input/output section modules and the at least one separate operating-section

module, the bus and the communication signal pattern is performed by connecting a plurality of board-side module-connecting connectors mounted on the mount board, to module-side connectors provided for the separate input/output section modules and the at least one
5 separate operating-section module.

5. A programmable logic control system according to claim 4, further comprising address recognition means for supplying each of the separate input/output
10 section modules and the at least one separate operating-section module with an address indicative of the mount position of the separate module when the board-side module-connecting connector is connected to the module-side connector.

15 6. A programmable logic control system according to claim 4, wherein electrical connection between the common control input/output unit, the bus and the communication signal pattern is performed by connecting a board-side control-input/output-unit
20 connecting connectors mounted on the mount board, to an input/output-unit connecting connector mounted on the common control input/output unit.

25 7. A programmable logic control system according to claim 4, wherein electrical connection between each of the separate input/output section modules and the at least one separate operating-section module, and the communication signal pattern of the mount board is

performed by connecting each pair of adjacent male and female connectors mounted on each of the separate input/output section modules and the at least one separate operating-section module.

5 8. A programmable logic control system according to any one of claims 5, wherein the common control input/output unit includes display means capable of performing multi-display showing various states thereof, the display means capable of displaying those states of
10 the objects which are recognized by the address recognition means..

 9. A programmable logic control system, substantially as hereinbefore described with reference to the accompanying drawings.



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Claims searched: 1-9

Examiner: Michael Prescott
Date of search: 12 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.P): G3N (NGBA1, NGBA4, NGBA, NGBD4, NGBD); H4P (PPK)

Int CI (Ed.6): G05B 19/04, 19/05; H04L 12/403

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 5038317 (Allen-Bradley Company) see whole document, in particular Figs 1, 2	1-8
X	US 4870564 (GE Fanuc Automation) see column 4 line 26 to column 5 line 11	1-8
X	US 4442504 (Allen-Bradley Company) see column 4 line 4 to column 6 line 25	1-8

X Document indicating lack of novelty or inventive step
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